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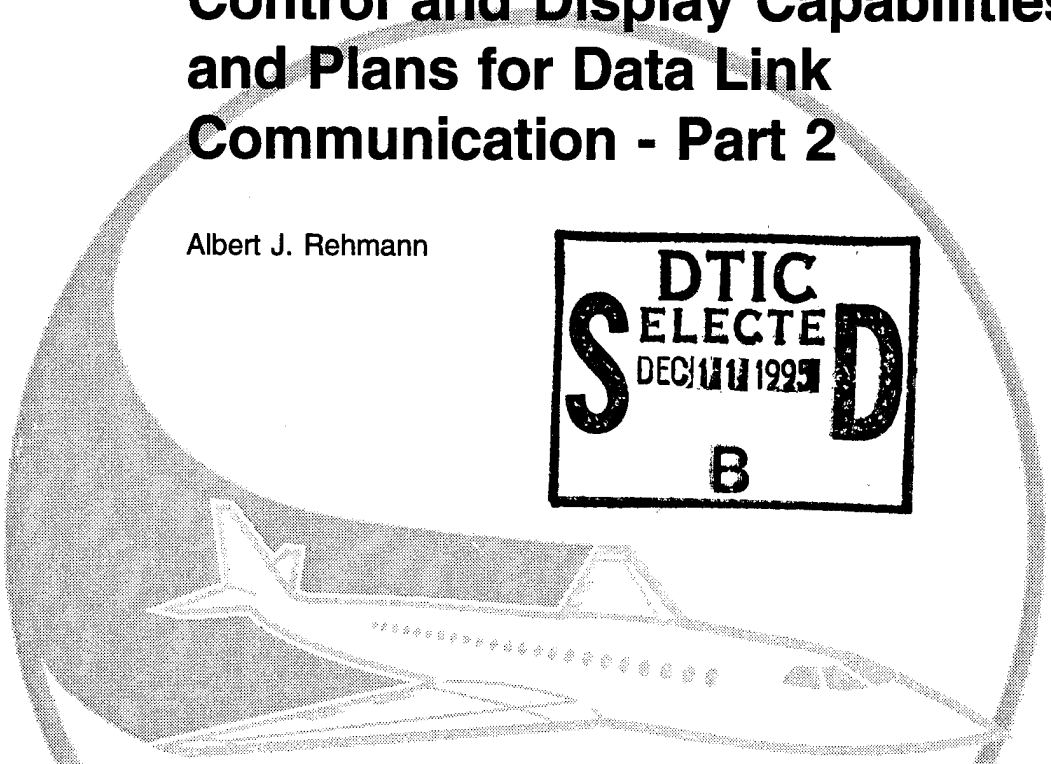
Report of Study on Airlines' Anticipated Near Future Cockpit Control and Display Capabilities and Plans for Data Link Communication - Part 2

Albert J. Rehmann



October 1995

DOT/FAA/CT-TN95/31

U.S. Department of Transportation
Federal Aviation Administration
Technical Center
Atlantic City Airport, NJ 08405

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN95/31		

4. Title and Subtitle	5. Report Date
Report of Study on Airlines' Anticipated Near Future Cockpit Control and Display Capabilities and Plans for Data Link Communication - Part 2	October 1995
	6. Performing Organization Code
7. Author(s) Albert J. Rehmann; S.L. Townsend, G. Yastrop, CTA Incorporated	8. Performing Organization Report No. DOT/FAA/CT-TN95/31
9. Performing Organization Name and Address CTA Incorporated 2500 English Creek Avenue, Suite 1000 Pleasantville, N.J. 08232	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.
	13. Type of Report and Period Covered Technical Note
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration Technical Center Atlantic City International Airport, NJ 08405	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report reviews the findings of a study conducted by CTA Incorporated for the Federal Aviation Administration (FAA) Technical Center Airborne Systems Technology Branch (ACD-320) Airborne Data Link Program. The following data were studied for each of seven airlines' anticipated near future fleets: (1) quantity of each aircraft model; (2) aircraft model cockpit configuration; (3) currently available Data Link services; (4) primary Data Link device location; and (5) Data Link equipment training needs. In addition, information was gathered that pertained to the airlines' interest in linking their simulators to the FAA Technical Center. These findings were then compiled to determine the airlines' specific plans for incorporating Data Link services into their fleets.

17. Key Words	18. Distribution Statement
Data Link Aircraft Communication Addressing and Reporting System (ACARS) Control and Display Unit (CDU)	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

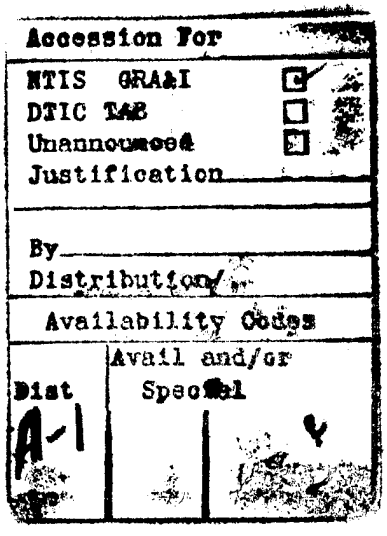
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	42	

PREFACE

This report is intended for research purposes only. The information presented reflects the surveyed airlines' anticipation of their activities within the next 5 years. In support of this effort, airline representatives gave their best estimates with regard to the questions posed in this study. The airlines have not committed themselves to this information.

The enclosed findings are not intended as a comparison of the studied airlines, but rather a collective assessment of the airlines' anticipated near future control and display capabilities and associated plans for Data Link communication.

The airline information outlined in this document is based on estimated quantities and information reported prior to the following dates: American Airlines, January 29, 1992; Continental Airlines, January 29, 1992; Delta Air Lines, February 27, 1992; Northwest Airlines, January 17, 1992; United, June 5, 1992; United Parcel Service, March 18, 1992; USAir, May 24, 1992.



ACKNOWLEDGEMENTS

Sincere appreciation is extended to the many individuals who assisted in providing input (many for the second time) to this ongoing research effort. A number of these individuals conducted research to provide answers to the Data Link Retrofit Study Questionnaire Continued collaboration such as that shown by the following individuals will ensure the future success of the Airborne Data Link Program: Don Dillman (American Airlines), Paul Ryan (American Airlines), John Mitchell (Continental Airlines), Alan Campbell (Delta Air Lines), Milton McKnight (Delta Air Lines), Doug Twinam (Delta Air Lines), Mike Arnold (Northwest Airlines), Dave Haapala (Northwest Airlines), Jon Pendleton (Northwest Airlines), Wayne Aleshire (United Airlines), Mike Frank (United Airlines), Bob Hilb (United Parcel Service), and Don DeBlasio (USAir).

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

EXECUTIVE SUMMARY

This report reviews the findings of a study conducted by CTA Incorporated for the Federal Aviation Administration (FAA) Technical Center Airborne Systems Technology Branch (ACD-320) Airborne Data Link Program. The following data were studied for each of seven airlines' anticipated near future fleets: quantity of each aircraft model; aircraft model cockpit configuration; current available Data Link services; primary Data Link device location; and Data Link equipment training needs. In addition, information was gathered that pertained to the airlines' interest in linking their simulators to the FAA Technical Center. These findings were then compiled to determine the airlines' specific plans for incorporating Data Link services into their fleets.

INTRODUCTION

PURPOSE.

In support of the Federal Aviation Administration (FAA) Technical Center Airborne Collision Avoidance and Data Systems Branch (ACD-320) Airborne Data Link Program, CTA INCORPORATED researched airlines' anticipated near future cockpit control and display capabilities and associated plans for Data Link communication. This effort was conducted in two parts. The first published study, entitled Study on Airlines' Anticipated Near Future Cockpit Control and Display Capabilities and Plans for Data Link Communication, DOT/FAA/CT-TN91/7, dated February 1991. This report is an expansion of the findings in the first study and will be used by the program as a planning reference.

BACKGROUND.

Data Link human factors research and development is becoming increasingly important to the FAA as Data Link Communication becomes more prominent in jet-transport category aircraft. As Data Link concepts and technology evolve, the uses for Data Link communications expand. Human factors issues must be resolved for a more effective, efficient, and safe Data Link system. The avionics equipment that flight crews will interact with for Data Link communication will require FAA certification. The FAA is developing standards for minimum characteristics and capabilities that constitute safe and effective Data Link system design. Human factors research must be performed as a vital step in the development of these minimum requirements.

The ACD-320 Airborne Data Link Program includes Data Link human factors research and development addressing areas pertinent to both the FAA Certification Office and the airline industry. This work involves researching Data Link human factors issues and concepts as well as developing simulator operational evaluations and flight tests. Current Data Link human factors research includes the interaction of the cockpit crew with the Data Link system to input information (control) and receive information (display). For example, based on survey data, information may be input via a touch sensitive screen or an eight-character keypad. Information may be displayed on a Flight Management System Control and Display Unit (FMS CDU), a weather radar screen or an Aircraft Communication Addressing and Reporting System (ACARS) screen.

This study, an expansion of previous research on Data Link control and display capabilities, further refines information pertaining to the airline industry usage of Data Link communication systems. It is intended to provide the FAA Technical Center with an accurate representation of the systems typically used by a large portion of the industry fleet. This knowledge is necessary to ensure that research conducted supports the intentions of the operational community.

DESCRIPTION OF STUDY.

The information for the DLRS2 was acquired through telephone conversations with officials and pilots of seven airlines and the distribution of a 16-page questionnaire, referred to as the Data

Link Retrofit Study - Part 2 Questionnaire (DLRS2Q), to the same airline representatives. The seven airlines that participated in the February 1991 study were again involved with DLRS2. They are: American Airlines, Continental Airlines, Delta Air Lines, Northwest Airlines, United Airlines, United Parcel Service, and USAir.

STUDY OBJECTIVES.

The DLRS2 encompassed the following objectives:

1. To determine the airlines' plans for incorporating Data Link into their fleets during the next 5 years.

2. To determine existing Data Link configurations of in-service aircraft.

3. To assess current and anticipated training needs with respect to the operational use of Data Link equipment.

4. To determine airlines' interest in linking their simulators to the FAA Technical Center.

5. To survey cockpit equipage of in-service aircraft.

METHOD OF DATA COLLECTION.

The DLRS2 included a 16-page questionnaire (DLRS2Q) directed to domestic airline flight operations managers, experienced pilots, and other knowledgeable airline officials. This questionnaire asked specific questions regarding type and number of aircraft in the fleet, plans for phasing in new aircraft, cockpit configurations and primary Data Link interface capabilities, hardware, and location. DLRS2Q also asked questions regarding present and future training requirements and present and future flight simulation facility usage. Telephone conversations provided further clarification and additional detailed information for the study.

REVIEW OF FINDINGS

GENERAL DISCUSSION.

In conducting the DLRS2, certain ground rules were followed. In order to protect information that may have been considered sensitive by the airlines, all quantities of aircraft are specified as percentages. Any references to the percentage amount of aircraft that will be acquired in the near future are estimates. Reported information is not to be construed as a commitment from the airlines.

To achieve the study objectives, DLRS2Q contained both qualitative and quantitative questions. Cooperation with the DLRS2 study objectives was generally favorable; the majority of the airline representatives responded with complete comments and specific data. The following subsections summarize the answers to DLRS2Q and additional comments of the airline representatives.

AIRLINE SPECIFIC INFORMATION.

The following subsections provide the responses of each of the seven airline representatives to DLRS2Q. Information gathered from telephone conversations is also included. Additional information is detailed in the tables found in appendix A. These tables contain the aircraft models in each airline fleet, percentage quantity of aircraft, primary Data Link hardware display devices, and Data Link device locations.

CURRENT FLEET COMPOSITION.

Figure 1, Composition of Studied Fleet by Airline depicts the allocation of the seven studied airlines. Figure 2, Composition of Studied Fleet by Aircraft Model identifies the aircraft models that comprise the studied fleet and the portion of the fleet that each model represents. The "studied fleet" refers to the total amount of aircraft reported by all the airlines that responded to the DLRS2 questionnaire. Small amounts of similar aircraft models were combined. For example, model A310-200 and model A310-300 are comparable aircraft that were combined for the purposes of this study.

ANTICIPATED FUTURE FLEET COMPOSITION.

The airlines were asked for estimates of their fleet composition for the year 2000. Quantities of aircraft models are expressed in percentages. The following example illustrates the method used to calculate the percentages.

In the sections that follow, airlines have been de-identified to protect data that are considered sensitive. For purposes of this report, only fleet composition information is necessary.

AIRLINE A. By the year 2000, this fleet will be modified to reflect the following composition: Model B757-200 will increase 86 percent. Model B767-300ER will increase 127 percent. Model F100 will increase 476 percent. Model MD83 will increase 150 percent. Model MDll will increase 280 percent. Model A300 will increase 16 percent. Model B727-200 will decrease 46 percent. The quantity of models MD83, B767-200, B767-200ER, DC10-10, and DC10-30 will remain static. Models B737-300, B747-SP, and B727-100 will not be in use by the year 2000.

AIRLINE B. Plans for near future fleet were not disclosed.

AIRLINE C. The airline representative indicated that models MD-ll, B757, and B767 will be increased approximately 30 percent. Airline C will add models MD-90 and B737-300/400 beginning in 1993. Quantity increases for specific models were not given. Model DC-9 will be phased out by December 1992.

AIRLINE D. By the year 2000, the fleet will be modified to reflect the following composition: Combined, Models A320 and A321 will increase 300 percent and serve as a replacement for model B727-200. Model B747-400 will increase 60 percent. Models A330, A340, and B757 will be added to the fleet, (quantities were not given). With very few exceptions, model B727-200

will not be in use by the year 2000. Model DC-9 will decrease at least 25 percent. The replacement of model DC-9 is currently under consideration.

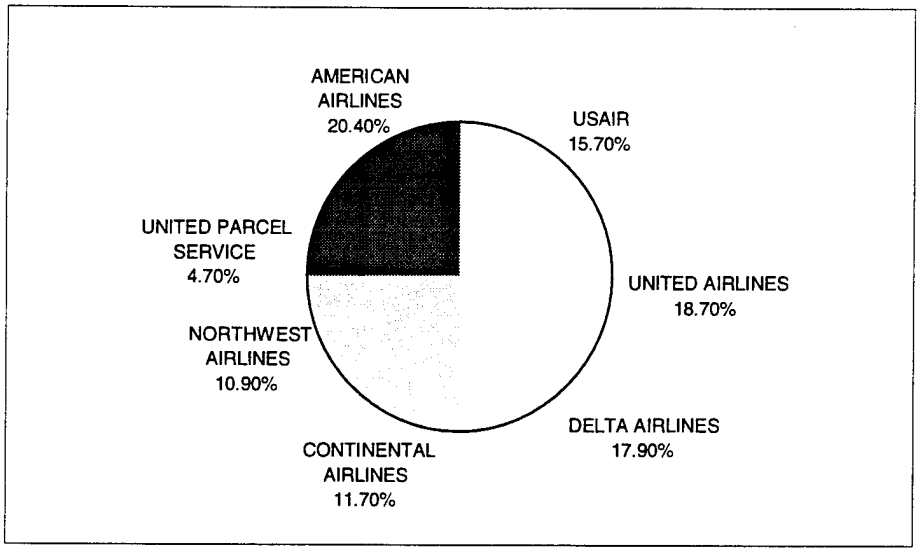


FIGURE 1. COMPOSITION OF STUDIED FLEET BY AIRLINE

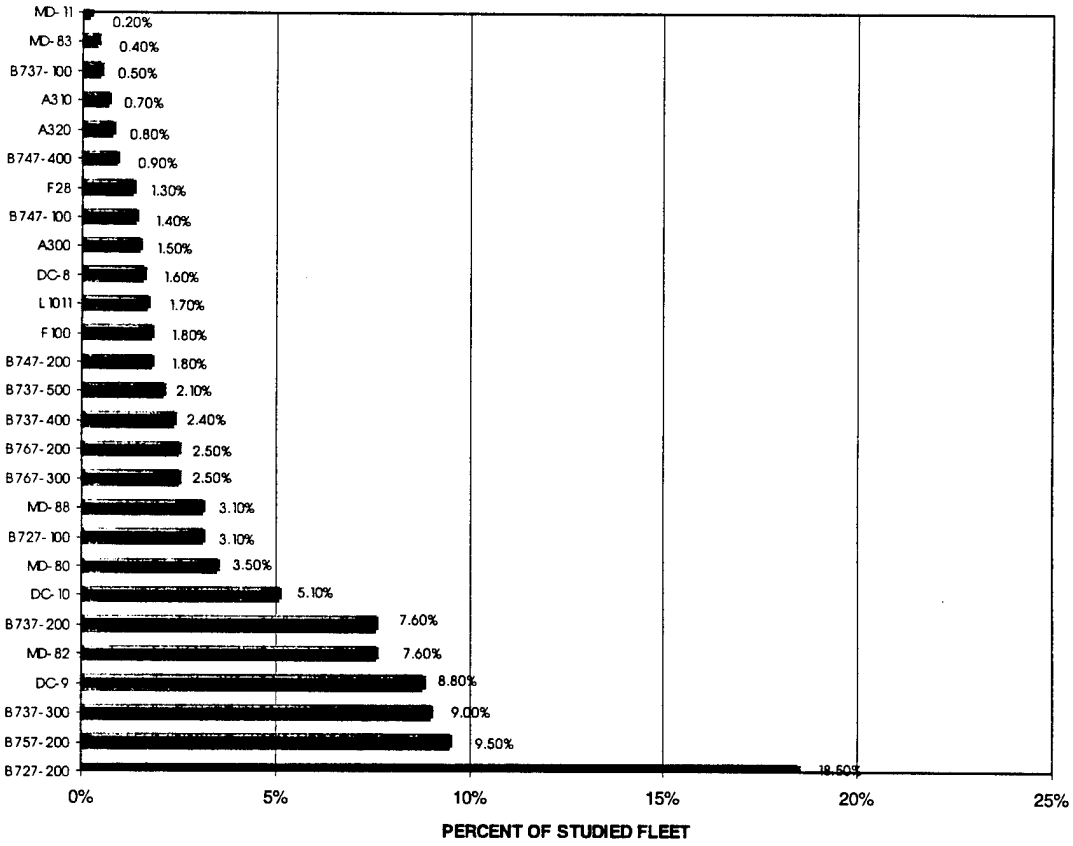


FIGURE 2. COMPOSITION OF STUDIED FLEET BY AIRCRAFT MODEL

AIRLINE E. By the year 2000, the fleet will be modified to reflect the following composition: Model 737-500 will increase 54 percent. Model B757-200 will increase 44 percent. Model B747-400 will increase 317 percent. Models B737-400, B767-300ER, and B777 will be added to the fleet. Model B727-100 will not be in use by the end of 1992. Models B737-200 and B747-SP will not be in use by 1995. Model B747-100 will not be in use by 1998. Airline E will phase out all non-Stage III aircraft by the year 2000.

AIRLINE F. The year 2000 the fleet will retain all current aircraft. Model B757 will increase 84 percent by 1997.

AIRLINE G. By the year 2000, the fleet will be modified to reflect the following composition: Model B757-200 will increase 150 percent. Model B767-200 will increase 18 percent. Model B737 will increase 25 percent. Model F28-1000 will not be in use by end of 1993.

COCKPIT CONFIGURATIONS.

The current cockpit configurations of each model aircraft also play an important role in the operation of Data Link communication devices. Cockpit configuration is deflned by the type of instrumentation technology and the number of crewmembers. A different suffix, (e.g., model B737-300 vs. model B737-400) does not denote a difference in cockpit configuration. Northwest Airlines cited an exception with their configuration of model B747. Model B747-400 is operated with a two-person crew. Models B747-100, B747-200, and B747 Freighter are all operated with three-person crews. Figures 3 through 6 depict aircraft models by cockpit configuration.

CONTROL AND DISPLAY CAPABILITIES.

The control and display capabilities for primary Data Link devices were reviewed for the total studied fleet. A primary Data Link device is defined as the device or display with which the flightcrew will have the most interaction to send and receive air traffic control (ATC) and weather service information. Information such as gate assignments and connecting flights is included, but not as fundamental information. In cases where an aircraft may use one display type to receive Data Link messages and another device to send Data Link responses or messages, the receiving display is considered the primary Data Link device. A different suffix, (e.g., model B737-300 vs. model B737-400) does not denote a difference in Data Link capabilities. United Parcel Service cited an exception with their configuration of model B727. Model B727-100 will have Data Link capabilities, model B727-200 will not be Data Link equipped. Figure 7 specifies the percentage of each airlines' fleet that is anticipated to have Data Link capabilities.

The primary Data Link display device is generally referred to as ACARS. The ACARS display is an Interactive Display Unit (IDU) that represents a Data Link display monitor with a touch sensitive screen. ACARS also has a monitor with a keypad (ACARS-keypad) for input. These monitors typically display eight lines of text with 16 characters per line. A third Data Link display type is represented by an ACARS unit with a keypad and a screen capable of displaying one or two lines of text (ACARS-single). A dedicated ACARS unit is a control and display unit (CDU)

that is solely dedicated to Data Link communication. A multifunctional control and display unit (MCDU) has the capability of handling a number of information systems including ACARS.

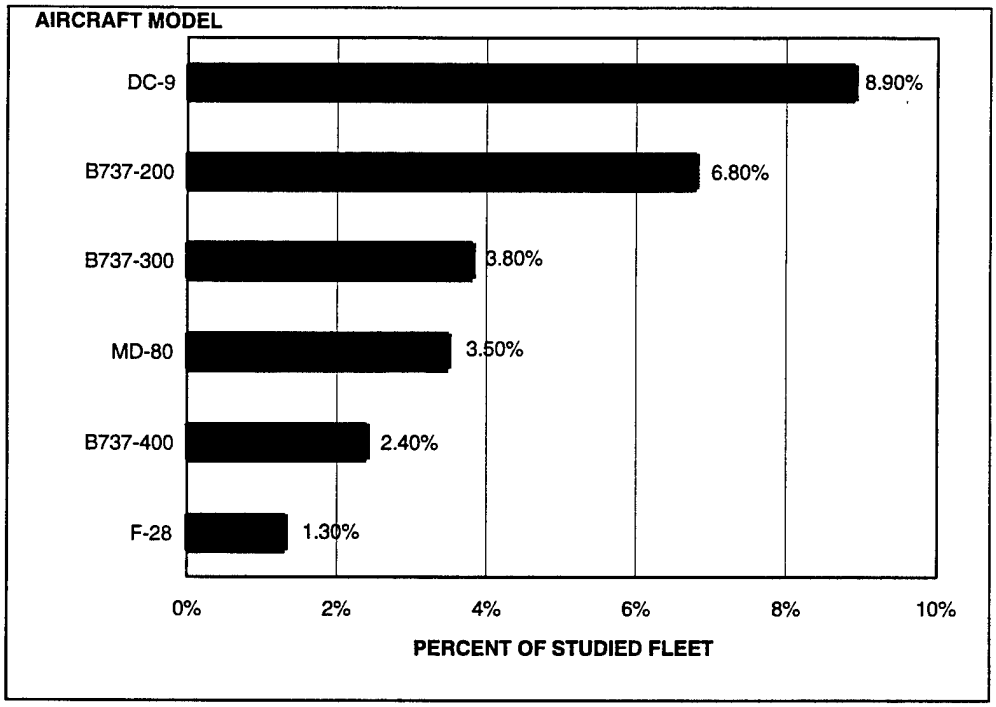


FIGURE 3. COCKPIT LAYOUT OF STUDIED FLEET - ANALOG, TWO-PERSON CREW

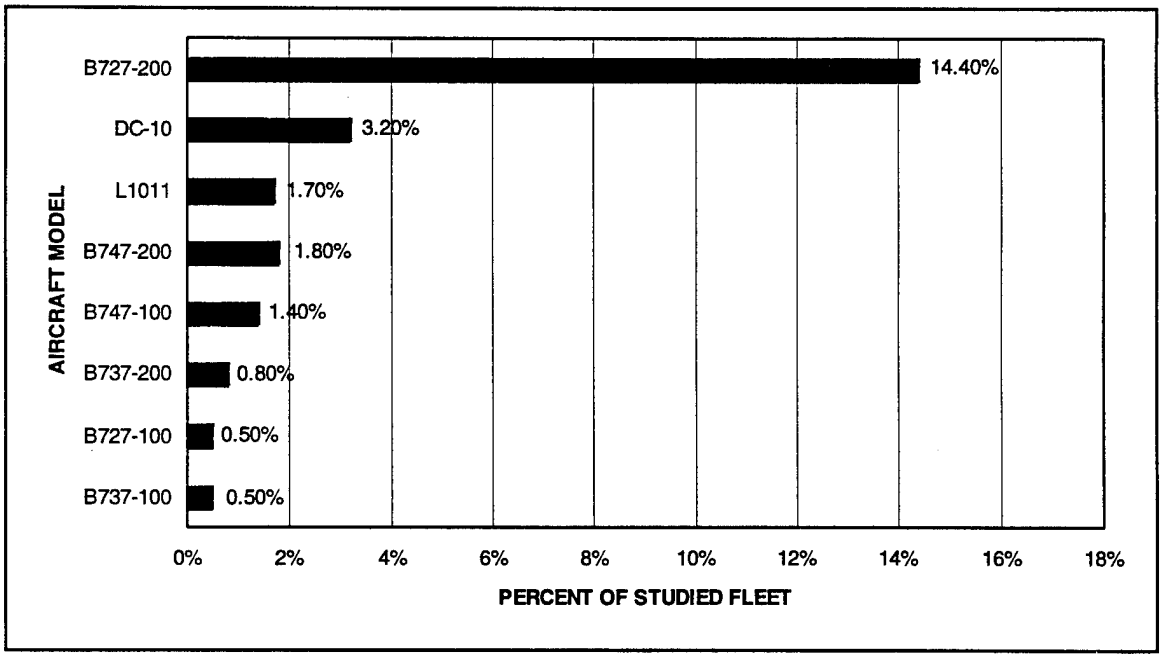


FIGURE 4. COCKPIT LAYOUT OF STUDIED FLEET - ANALOG, THREE-PERSON CREW

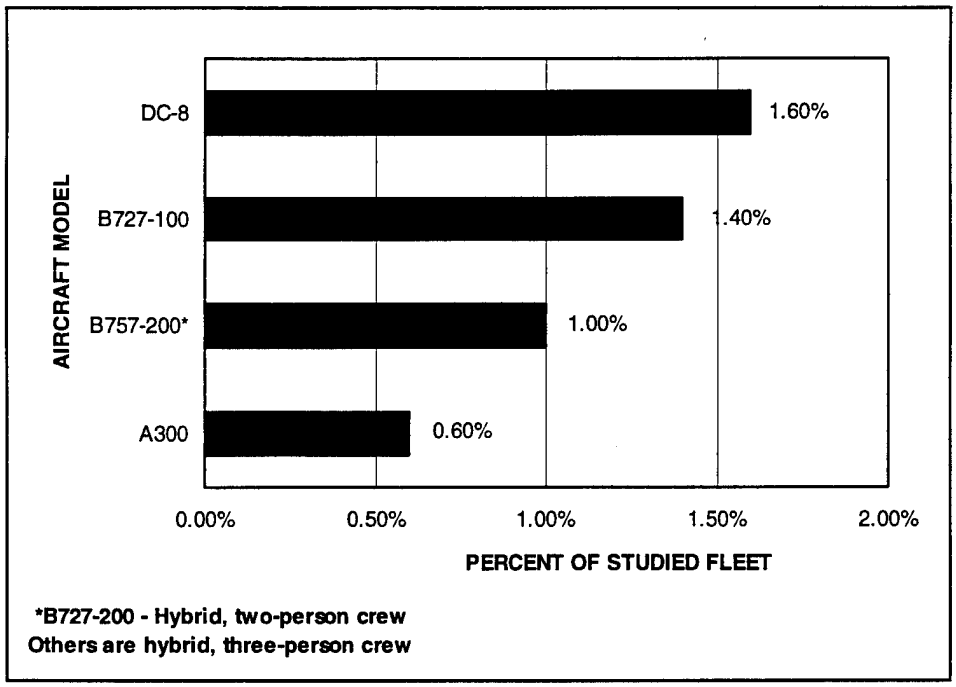


FIGURE 5. COCKPIT LAYOUT OF STUDIED FLEET - HYBRID, TWO AND THREE-PERSON CREW

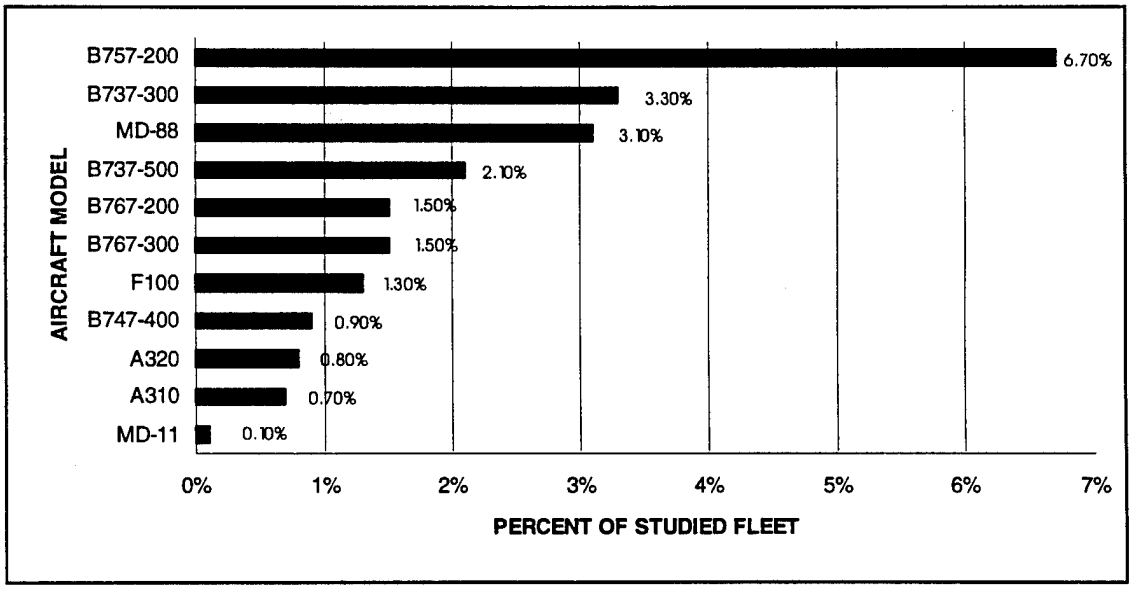


FIGURE 6. COCKPIT LAYOUT OF STUDIED FLEET - GLASS, TWO-PERSON CREW

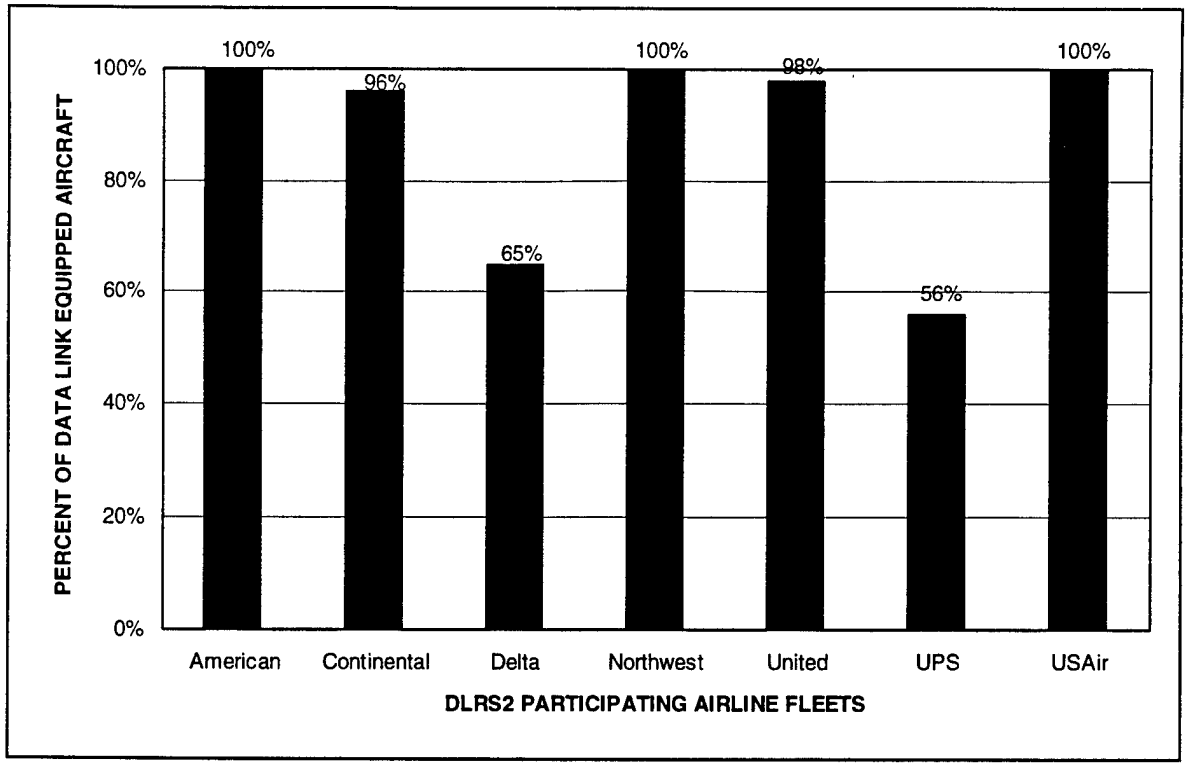


FIGURE 7. DATA LINK EQUIPPED AIRCRAFT BY AIRLINE FLEET

1. American Airlines reports 100 percent Data Link equipped aircraft with ACARS as the primary Data Link control and display device.

2. Continental Airlines expects to have 100 percent Data Link capabilities by the end of 1992. Data Link equipped aircraft are using ACARS as the primary Data Link control and display device.

3. Delta Air Lines estimates 55 percent of the fleet is equipped with Data Link communication capability. Data Link equipped aircraft are using ACARS as a Data Link device to present the following information: Off, On, Out In (OOOI) operational reports and engine monitonng.

4. Northwest Airlines reported 100 percent Data Link equipped aircraft with ACARS as the primary Data Link control and display device.

5. United Airlines estimates that 98 percent of the fleet is Data Link equipped using ACARS as the primary Data Link control and display device. Present capabilities include airline operational control, predeparture clearance, ATC Data Link and oceanic ATC (waypoint and two-way Data Link satellite communication in the 747-400).

6. United Parcel Service reports that 50 percent of its fleet is Data Link equipped. Data Link equipped aircraft are using ACARS as the primary Data Link control and display device.

7. USAir reports that the 100 percent of its fleet is Data Link equipped. ACARS is used as the primary Data Link control and display device. Capabilities and primary uses include OOOI operational reports, predeparture clearance, weather, and free text.

DISPLAY DEVICE LOCATION.

Data Link display location is very important to the operation of Data Link communication devices. The placement of the primary Data Link interface was requested for the type of aircraft in each fleet. Anticipated location changes within the next 5 years were also requested.

Appendix B, Airline Data Link Display Device Location, contains the figures that show placement of the primary Data Link device in the cockpit.

HARDWARE EQUIPAGE.

The different types of Data Link hardware currently in use include touch sensitive screen monitors, monitor with attached keypads, and standard and wide carriage printers. The Data Link hardware used by each airline is reported here; Data Link display device locations are presented in appendix A. In addition, a question was asked regarding how many, and what type of automated systems are available in the cockpit. Most respondents considered this question imprecise for Data Link related analysis. The intent of the question was to gain insight to the various systems that are used simultaneously, and how the use of Data Link systems effect the workload of the flight crew.

The following information was reported by the airlines:

AMERICAN AIRLINES. Teledyne AEEC 597/724B, Sunstrand AEEC 597/724B, and Collins AEEC 724B are used as the Data Link display device. Printers are on all aircraft. The ACARS display is separate from the printer.

CONTINENTAL AIRLINES. Teledyne equipment is used as Data Link display devices. One Management Unit (MU) with single control will be in place by the end of 1992. Touch sensitive screens will be installed in all new aircraft.

DELTA AIR LINES. Collins, Bendix, and Teledyne equipment is used for Data Link displays. Equipment consists of Collins touch sensitive screen, Bendix and Teledyne keypad, and both standard and wide carria~e printers.

NORTHWEST AIRLINES. Bendix 724/724B display screen and keypad are used as Data Link display devices. Presently, all messages are sent only to the display screen. Future models B747-400, A320, and A340 will have printers. Other automated equipment reported included: the Digital Flight Data Acquisition Unit (DFDAU) on model B757; Performance Management System on models B747-100, B747-200, B747-Freighter; and Flight Management Computer on models B757, B747-400, A330, and A340.

UNITED AIRLINES. Collins touch sensitive screens are used as the MCDU. Teledyne equipment is also used. Touch sensitive screens are on the majority of models B757, B767, and B737. The Honeywell MCDU is used on B747-400. Printers are on all glass aircraft, models B737-300, B737-500, B747-400, B757-200, B767-200, and B767-300.

UNITED PARCEL SERVICE. All Data Link equipped aircraft have Collins IDU and MU used as Data Link display devices. All are touch sensitive screens.

Other automated equipment reported included: United Parcel Service also reported the Litton 92 Inertial Navigation System on models DC-8 and B747.

USAIR. Teledyne 597 is used as Data Link display device. All aircraft have touch sensitive screen monitors and no keypads or printers are used.

INFORMATION PRESENTATION.

Data Link information can be displayed on screens that are shared with other systems in the aircraft cockpit. The Flight Management Computer (FMC), weather radar, and Traffic Collision Avoidance System (TCAS) are systems that can share the same display screen.

1. American Airlines did not report information on Data Link information screen presentation.

2. Continental Airlines has TCAS information and primary Data Link information presented on the same screen.

3. Delta Air Lines aircraft are equipped with Bendix ACARS that will display data link information on the weather radar display.

4. Northwest Airlines presents primary Data Link ACARS and FMC sharing on models A320, A340, and B747-400. ACARS also shares with weather radar on B757. This situation may change to a dedicated Data Link ACARS CDU. All other models have dedicated ACARS screens. Models B747-400 and A340 have three Multifunctional Control and Display Units (MCDUs), so pilots tend to dedicate the center MCDU to ACARS. Model A320 is equipped so that the ACARS information is time-shared with FMC, but this configuration may change to include three MCDUs.

5. United Airlines the FMC only shares the ACARS on model B747-400. All other models have dedicated Data Link ACARS displays.

6. United Parcel Service has ACARS units as primary dedicated Data Link displays.

7. USAir has ACARS units as primary dedicated Data Link displays.

Airlines anticipate presentation of the following Data Link information on the display screen: Frequency selection for voice communication, weather, flight plans, weight and balance,

predeparture clearance (PDC), ATC strategic clearances, operational test messages, engine performance, OOOI times, Automated Terminal Information Service (ATIS), crew performance monitoring, airline operational control functions, company data, and oceanic and en route communication.

The type of information that the airlines anticipate being presented on a Data Link printer is: PDC, ATIS, oceanic clearance, weather, FMC/Omega routes, reclean information, maintenance information, upper air weather, and weight and balance data.

PDC, digital ATIS, oceanic track clearances, weather, and way point reports were reported as the available FAA-provided services. Transfer of communication is mentioned as the next logical Data Link function to be implemented domestically. Three airlines anticipated limited 2-way communication (ATC) in oceanic airspace this year.

For the information that is currently being presented, weather, PDC, weight and balance, and turbulence data are considered the "most useful." ATIS, Oceanic track clearance, and flight following functions (i.e., more consistent holding/ETA updates) are cited as important developments for the next 5 years. ATC and weather graphics are considered important in the long term.

MANUFACTURERS' INFLUENCE ON DATA LINK IMPLEMENTATION.

The airlines perception of the impact of the manufacturers' decisions on operational implementation of Data Link varied. Two central themes were evident; precertification and implementation delays. A summary of comments follows:

Precertification of specific Data Link equipment by the airframe manufacturer can be beneficial if several options are provided. If the manufacturer provides only one certified system, the airline has two choices; adapt to the provided system capability or procure the preferred system and initiate the necessary certification procedures. The latter incurs significant administrative and engineering expenses.

Airframe manufacturers' process delays have significant impact on timely implementation of Data Link technology. FMC and automated terminal information service interfaces require certification controlled by the airplane manufacturer. A large need exists for the airframe manufacturers' specifications regarding the FMS and ACARS interfaces. A standard FMC ACARS interface does not exist. Some manufacturers have no interest in Data Link satellite communications. One airline cited concerns regarding satellite communication equipment for Data Link. Antenna location restrictions were also cited as a concern.

After a requirement has been identified to the manufacturer, the implementation time can vary from 6 months to 2 years or more. The required Request for Quote (RFQ) and Airborne Electronics Engineering Committee (AEEC) specification must be submitted. Level 2 or 3 certification must be determined. All of these elements play a part in the process of determining

the length of time between requirement identification and cockpit use of Data Link communication equipment.

OPERATING PROCEDURES AND TRAINING.

The operating procedures in the cockpit, as they pertain to the Data Link communication equipment, are summarized here. A consensus of the airlines described the ACARS operating procedures as "pretty standard, all crewmembers can easily operate the unit."

In a two-person cockpit configuration, ACARS is typically the responsibility of the First Officer (or the pilot not flying, PNF). In the three-person cockpit, ACARS operation is typically the responsibility of the flight engineer (FE). If the FE is busy, the PNF will operate the unit.

There was a sense that special training techniques or procedures are not needed for the ACARS unit operation. ACARS training is a small part of 1 day in class room training. Suggestions were made to improve the unit, (more logical menu locations, consistent screen entries) so that minimal to no training is required.

FLIGHT DATA RECORDING.

All airlines recognized the need to record Data Link information. It is felt that the need exists to record the Data Link communication information, but only one of the airlines indicated tentative plans. Another stated that Data Link recording capabilities would be provided when federally mandated.

FLIGHT SIMULATION.

Simulation of real-world conditions is a research technique used by the FAA Technical Center to evaluate Data Link systems. Information gained is invaluable in quantifying the Data Link utility. Questions were asked to determine the airlines' flight simulation capabilities, ATC environment simulation, and their interest in participating in FAA simulation activities. The following is a summary of responses:

AMERICAN AIRLINES. American Airlines reported full-motion simulation capabilities. Data Link operations are not a simulation priority. Whether or not the simulation included a realistic ATC environment was not known. No response was given to the question of connection to the FAA Technical Center.

CONTINENTAL AIRLINES. Continental Airlines conducts simulations at Houston Intercontinental, Los Angeles International, Newark International, and Miami International airports. A realistic ATC environment is not incorporated within the simulations. They expressed interest in participating with FAA Technical Center simulations.

DELTA AIR LINES. Each aircraft in the fleet has at least one dedicated Level C or D full-flight simulator. ACARS equipment in the simulators is nonfunctional. The simulators have not been

connected to an air traffic system within a realistic ATC environment. They expressed interest in flying simulators within a realistic air traffic environment through the FAA Technical Center.

NORTHWEST AIRLINES. Northwest Airlines has at least one simulator for each of the aircraft listed in its fleet. The simulators have not been connected to an air traffic system within a realistic ATC environment. They expressed interest in flying simulators within a realistic air traffic environment through the FAA Technical Center.

UNITED AIRLINES. United Airlines has models B747-400 and B767 simulators. Creating a realistic ATC environment is currently under development. They expressed interest in flying simulators within a realistic air traffic environment through the FAA Technical Center.

UNITED PARCEL SERVICE. United Parcel Service has five simulators; one model B757, two model DC-8, and two model B727. One of each are Level D simulators. The simulators have not been connected to an air traffic system within a realistic ATC environment. They expressed interest in flying simulators within a realistic air traffic environment through the FAA Technical Center.

USAIR. No response was given to the topic of aircraft flight simulation.

CONCLUSIONS

The Federal Aviation Administration (FAA) Technical Center Airborne Data Link Program research plans include selection of Data Link displays that reflect the airline industry's interests. Based on the provided information, prevalent devices in the current fleet are:

1. Aircraft Communication Addressing and Reporting System (ACARS) Interactive Display Unit (IDU) in models B737-200 and B737-300.

2. ACARS Control and Display Unit (CDU)/Multifunctional Control and Display Unit (MCDU) in model B757-200.

The locations of these units are varied; a common location is not indicated. See appendix B, Cockpit Placement of Data Link Devices, for locations of the devices by the airlines.

Three airlines mentioned plans for expanded use of three MCDUs. Where three MCDUs are used, one unit would be dedicated to presenting primary Data Link communication information.

The need to record Data Link communication information was recognized. Using the flight data recorder for this purpose was tentatively proposed by one airline. No plans were identified by the remainder. One suggested that they would do so when federally mandated.

Training discussion reflected the airlines' use of ACARS for the Data Link communications. ACARS training was not considered a priority issue. The consensus was that the units were fairly easy to understand and operate. Suggestions for improvement involved developing more logical

menu locations and consistent screen entries. Significant interest was expressed for interaction of the airlines' flight simulator programs with the FAA Technical Center simulation capabilities. Information regarding simulation availability, technical interface requirements, and the type of available environments was requested for the establishment of this capability.

AIRLINE SPECIFIC INFORMATION
APPENDIX A

AIRCRAFT MODEL	QTY (%)	DATA LINK DISPLAY DEVICE	LOCATION
B727-100	5.8%	ACARS single	*
B727-200	20.2%	ACARS single	*
B737-300	0.7%	Information not reported	*
B747-SP	0.3%	Information not reported	*
B757-200	8.5%	ACARS keypad	*
B767-200	4.8%	ACARS single	*
B767-300	3.1%	ACARS single	*
DC-1010	7.9%	ACARS single	*
DC-1030	1.6%	ACARS single	*
MD-11	0.8%	MCDU	*
MD-82	37.1%	information not reported	*
MD-83	2.0%	information not reported	*
F100	2.4%	ACARS IDU	*
A300	4.8%	ACARS keypad	*

* American Airlines did not report Data Link device placement information.

FIGURE A-1. AMERICAN AIRLINES

Aircraft Model	QTY (%)	DATA LINK DISPLAY DEVICE	LOCATION
B727-100	3.9%	ACARS single, Wx radar	*
B727-200	27.9%	ACARS single, Wx radar	*
B737-100	4.2%	NOT DATA LINK EQUIPPED	
B737-200	7.0%	ACARS single, Wx radar	*
B737-300	15.5%	ACARS single, Wx radar	*
B747-100	0.6%	ACARS single, Wx radar	
B747-200	1.7%	ACARS single, Wx radar	
DC-9	11.6%	ACARS single, Wx radar	
DC-10	4.2%	ACARS single, Wx radar	
MD-80	18.6%	ACARS single, Wx radar	
A300	4.8%	ACARS single, WX radar	

* Continental Airlines reported limited information regarding Data Link device placement.

FIGURE A-2. CONTINENTAL AIRLINES

AIRCRAFT MODEL	QTY (%)	DATA LINK DISPLAY DEVICE	LOCATION
B727-200	28.2%	NOT DATA LINK EQUIPPED	
B737-200	10.9%	*	4
B737-300	2.4%	*	4
B757-200	13.1%	*	4
B767-200	2.8%	*	4
B767-300	4.2%	*	4
B767-300ER	1.7%	NOT DATA LINK EQUIPPED	
DC-9	5.3%	NOT DATA LINK EQUIPPED	
MD-11	0.4%	*	9
MD-80	17.3%	*	6
L1011	9.8%	*	10
A310-200	1.3%	*	5
A310-300	2.6%	*	5

* Delta Air Lines reported ACARS IDU, ACARS single and ACARS keypad devices present in 65% of their fleet. Related aircraft model information was not given.

FIGURE A-3. DELTA AIR LINES

AIRCRAFT MODEL	QTY (%)	DATA LINK DISPLAY DEVICE	LOCATION
B727-200	18.1%	ACARS keypad	5
B747-100	4.5%	ACARS keypad	7
B747-200	7.5%	ACARS keypad	7
B747-Freighter	1.8%	ACARS keypad	7
B747-400	3.0%	MCDU	7
B757-200	9.9%	ACARS keypad	3; 7
DC-9	37.7%	ACARS keypad	4
DC-10	7.5%	ACARS keypad	7
MD-80	2.4%	ACARS keypad	4
A320	7.5%	MCDU	2, 4; 7

FIGURE A-4. NORTHWEST AIRLINES

AIRCRAFT MODEL	QTY (%)	DATA LINK DISPLAY DEVICE	LOCATION
B727-200	17.6%	ACARS IDU	6
B737-200	11.5%	ACARS IDU	6
B737-300	17.6%	ACARS IDU	6
B737-500	11.5%	ACARS IDU	6
B747-100	2.3%	ACARS keypad	10
B747-SP	1.8%	NOT DATA LINK EQUIPPED	
B747-200	1.2%	ACARS keypad	*
B747-400	3.2%	ACARS IDU	2,4,8
B757-200	15.8%	ACARS IDU	8
B767-200	3.3%	ACARS IDU	8
B767-300	4.2%	ACARS IDU	2,4,8
DC-10	10.0%	ACARS IDU	*

FIGURE A-5. UNITED AIRLINES

AIRCRAFT MODEL	QTY (%)	DATA LINK DISPLAY DEVICE	LOCATION
B727-100	17.6%	ACARS IDU	10,5; 5
B727-200	11.5%	NOT DATA LINK EQUIPPED	
B747-100	17.6%	ACARS IDU	5
B757-200	11.5%	ACARS IDU	7
DC-8	2.3%	ACARS IDU	10; 1

FIGURE A-6. UNITED PARCEL SERVICE

AIRCRAFT MODEL	QTY (%)	DATA LINK DISPLAY DEVICE	LOCATION
B727-200	3.4%	ACARS IDU	5
B737-200	17.0%	ACARS IDU	5
B737-300	21.2%	ACARS IDU	5
B737-400	15.5%	ACARS IDU	5
B757-200	2.1%	ACARS keypad	7
B767-200	2.3%	NOT DATA LINK EQUIPPED	7
DC-9	15.3%	ACARS keypad	4
MD-80	6.5%	ACARS IDU	4,4,8
F100	8.4%	ACARS IDU	5
F28-1000	3.3%	ACARS IDU	7
F28-4000	5.0%	ACARS IDU	7

FIGURE A-7. USAIR

COCKPIT PLACEMENT OF DATA LINK DEVICES
APPENDIX B

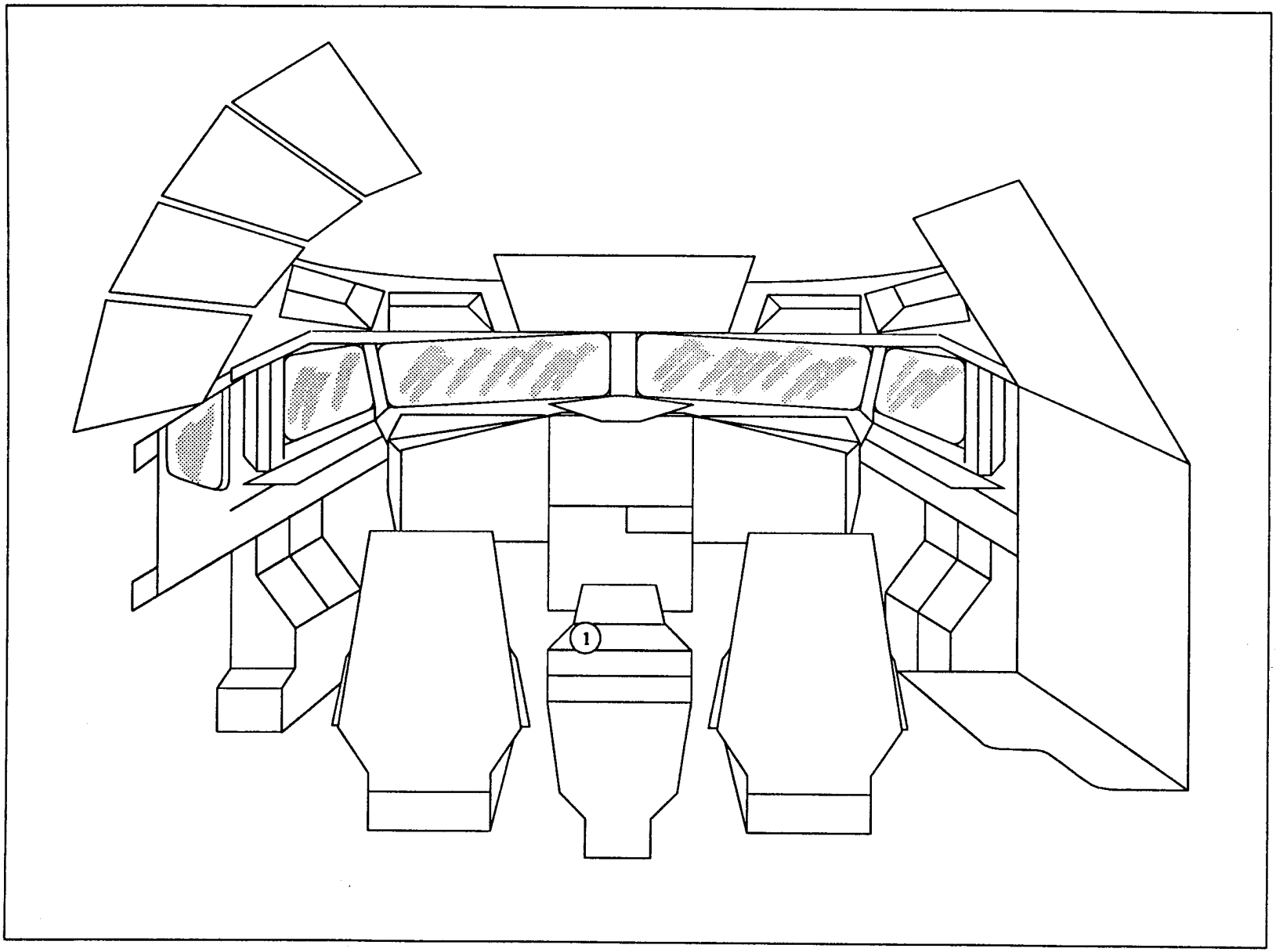


FIGURE B-1. DATA LINK DEVICE LOCATION 1
CENTER PEDESTAL LEFT

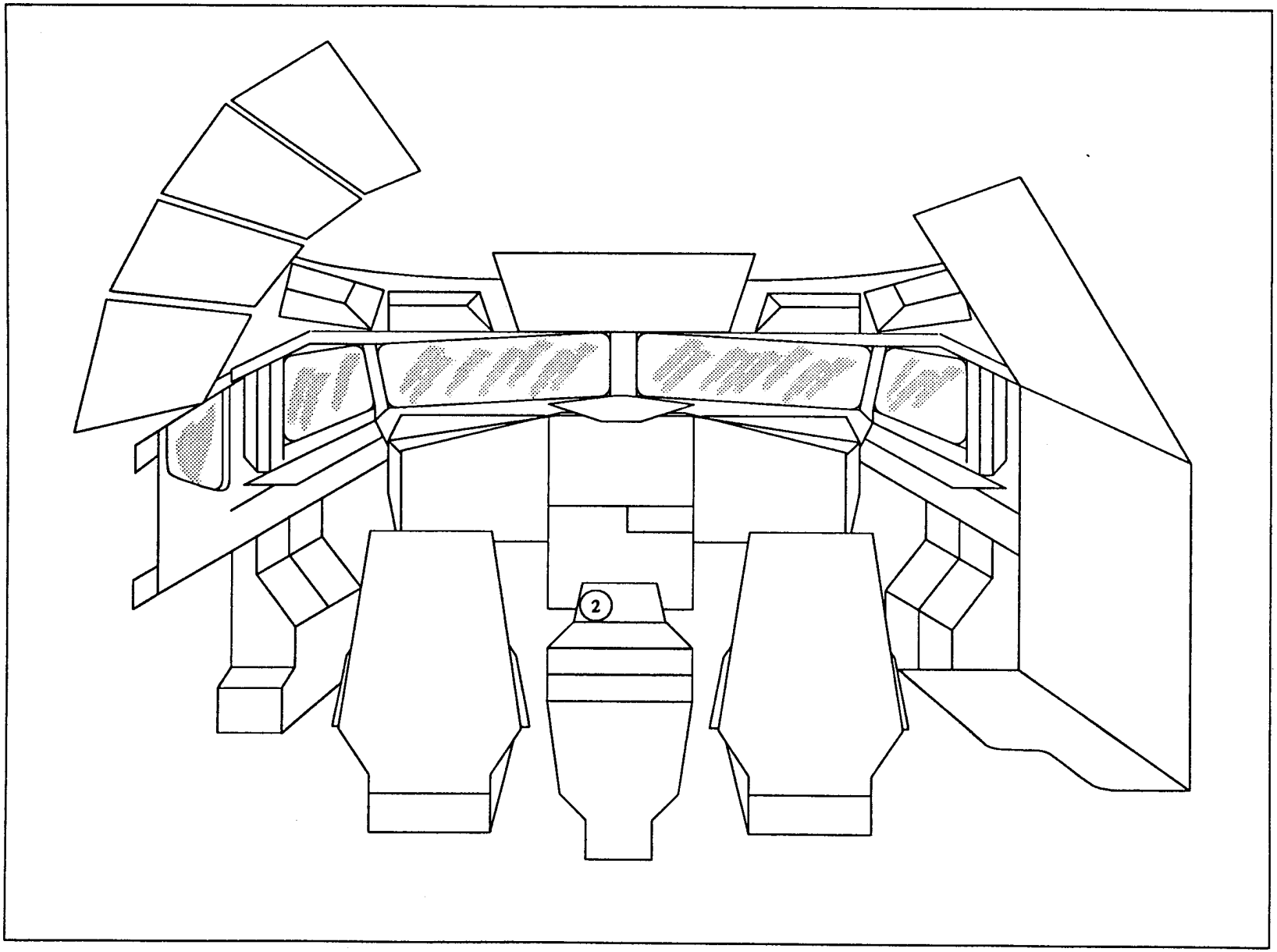


FIGURE B-2. DATA LINK DEVICE LOCATION 2
CENTER PEDESTAL FORWARD LEFT

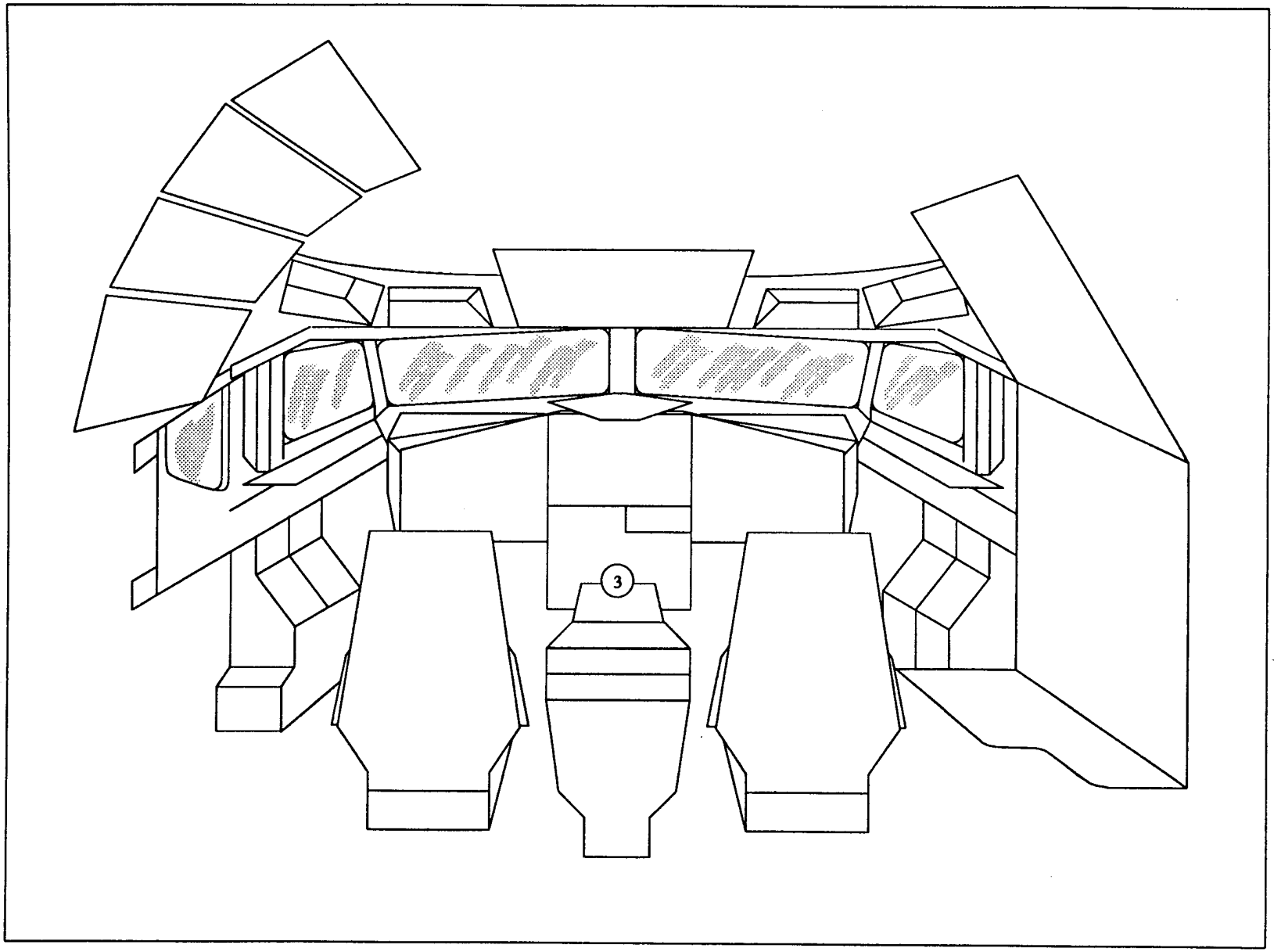


FIGURE B-3. DATA LINK DEVICE LOCATION 3
CENTER PEDESTAL FORWARD TOP MIDDLE

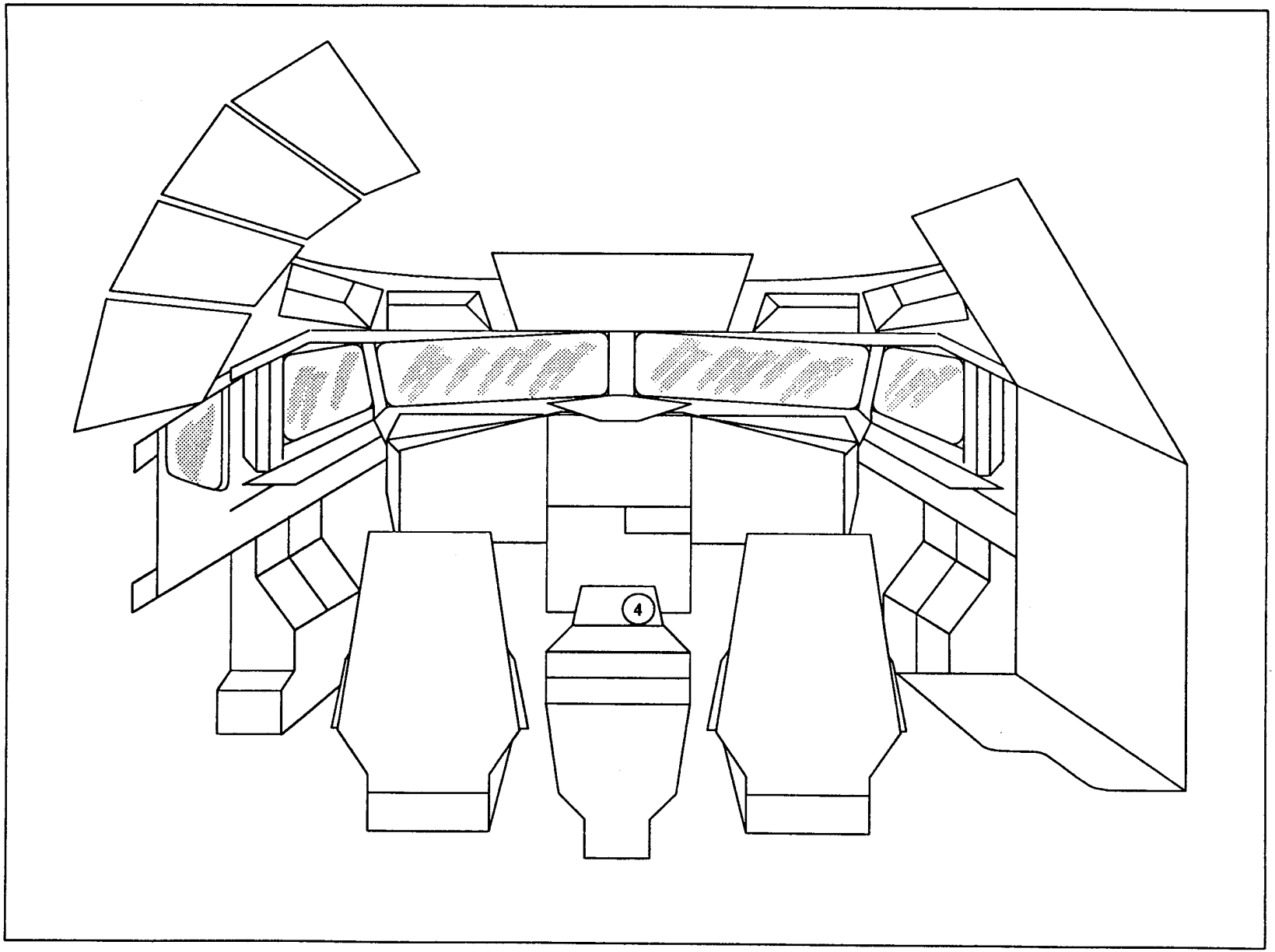


FIGURE B-4. DATA LINK DEVICE LOCATION 4
CENTER PEDESTAL FORWARD RIGHT

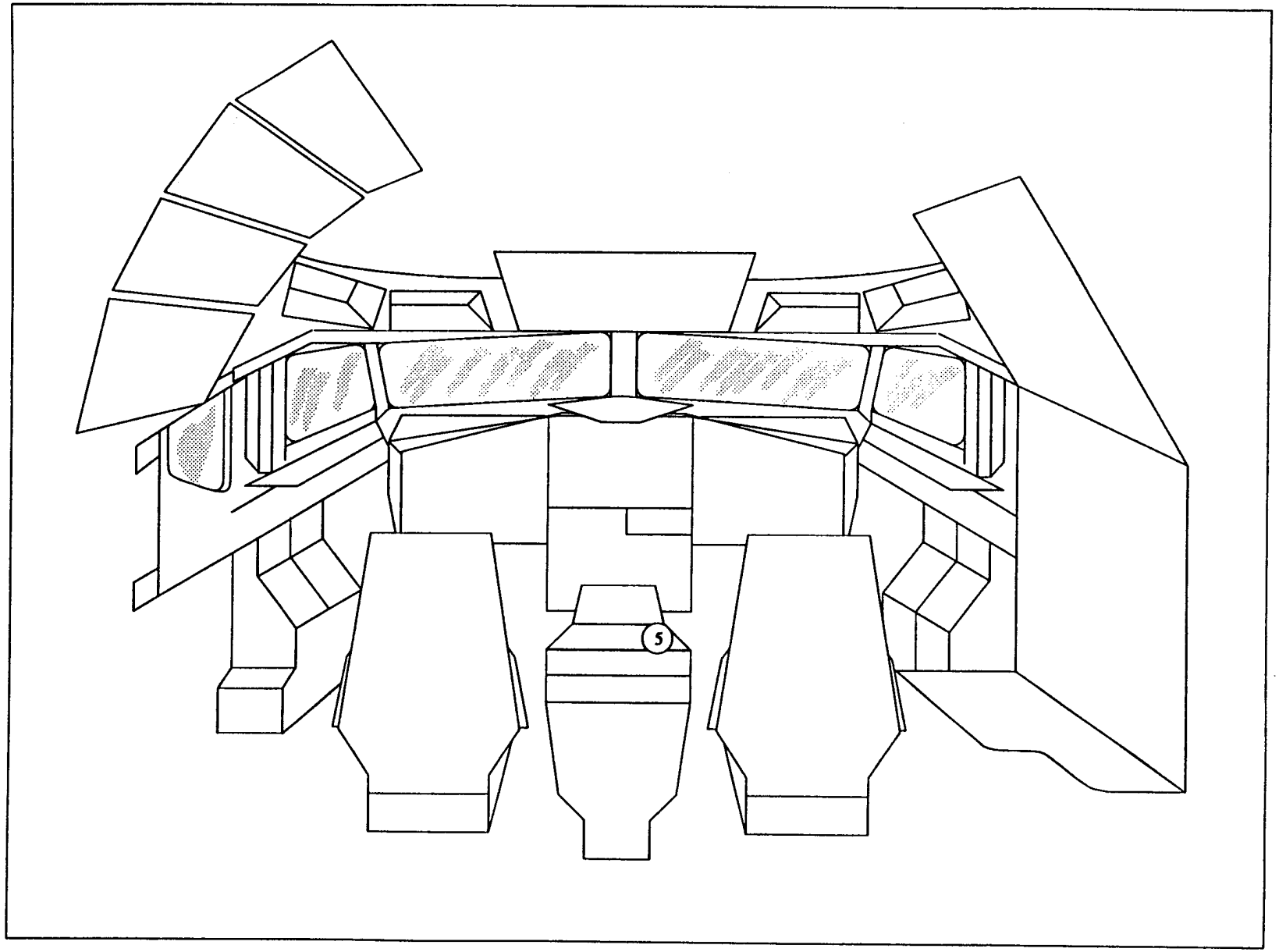


FIGURE B-5. DATA LINK DEVICE LOCATION 5
CENTER PEDESTAL RIGHT

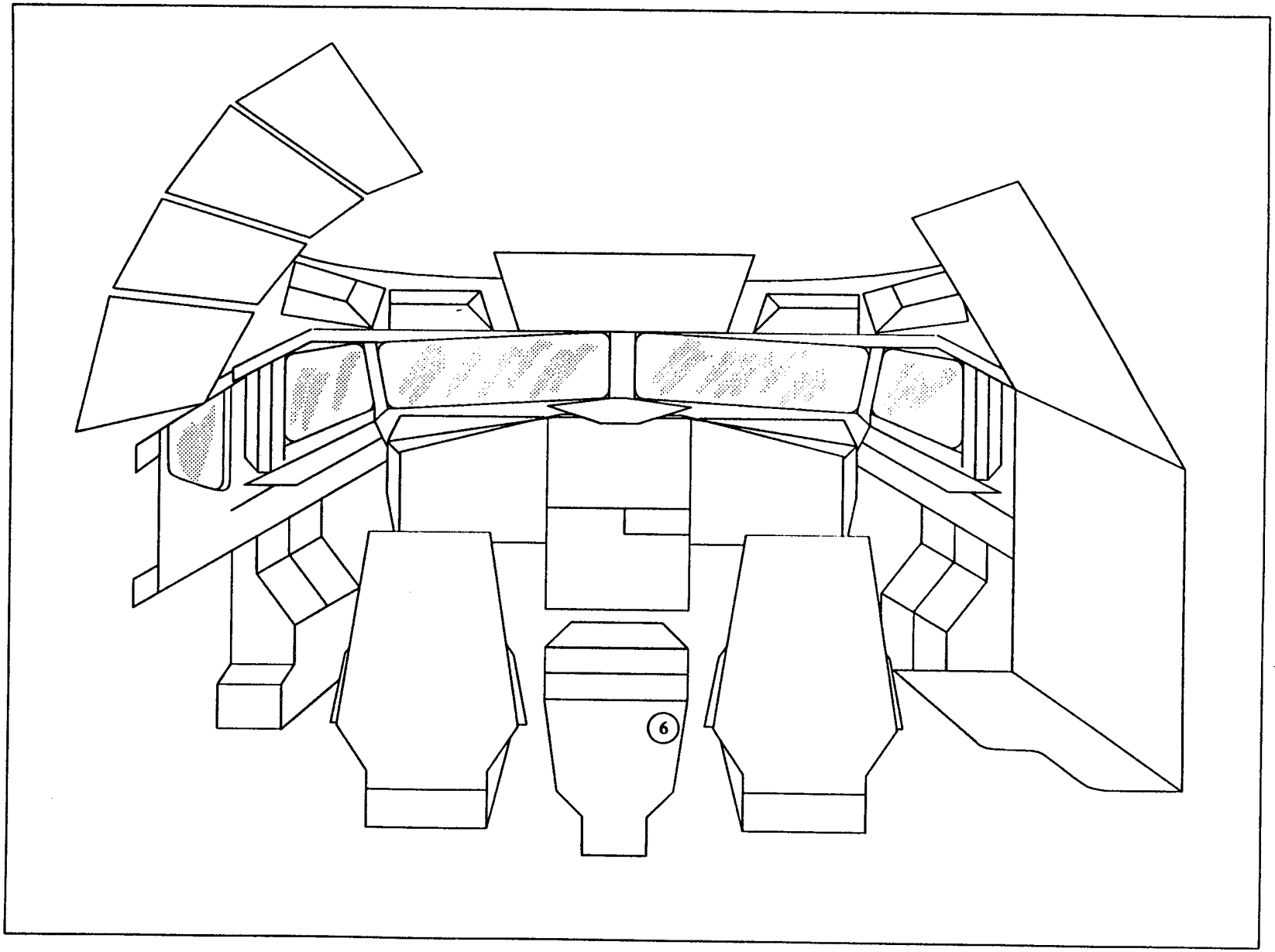


FIGURE B-6. DATA LINK DEVICE LOCATION 6
CENTER PEDESTAL VERTICAL RIGHT

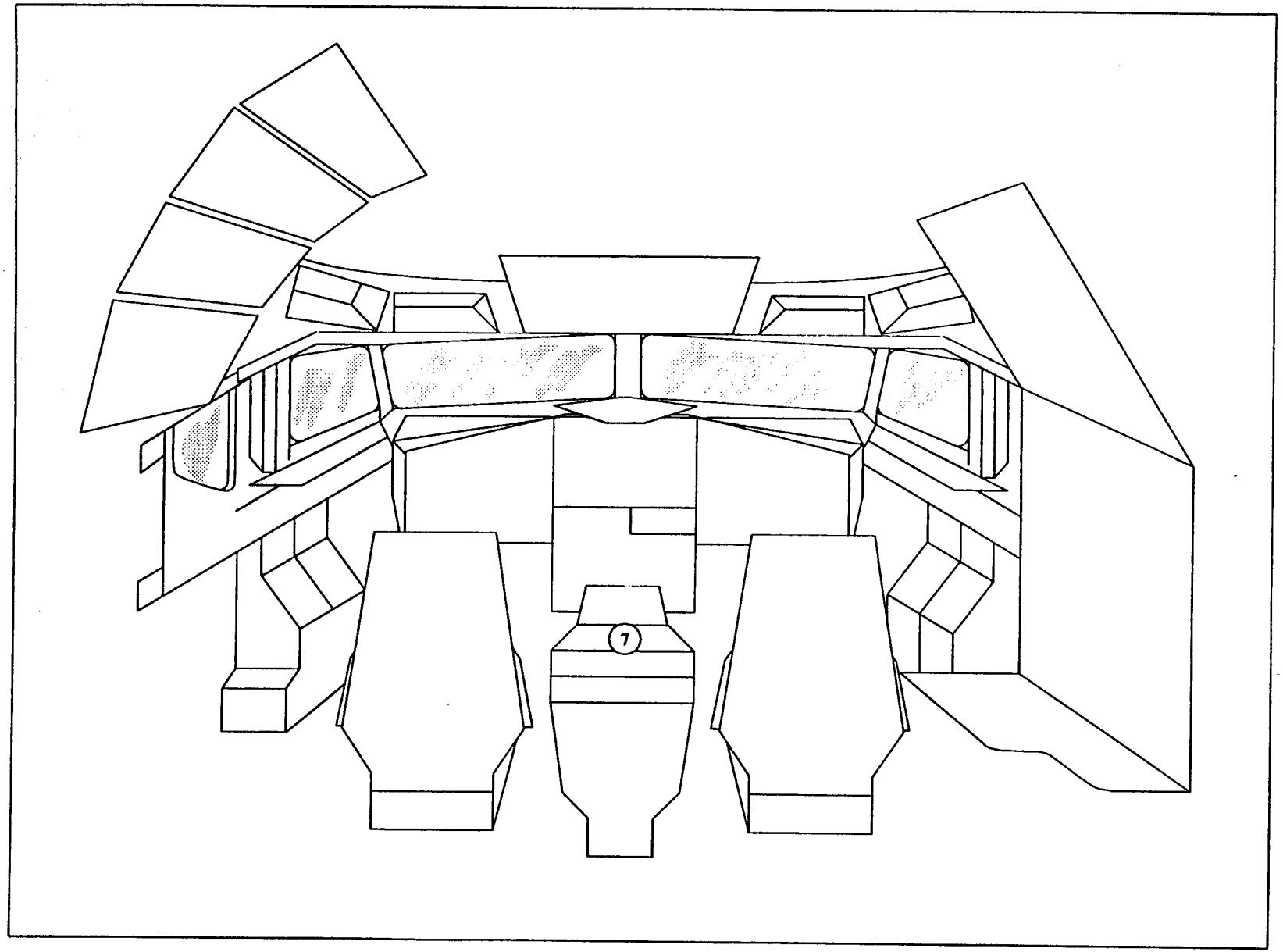


FIGURE B-7. DATA LINK DEVICE LOCATION 7
CENTER PEDESTAL MIDDLE

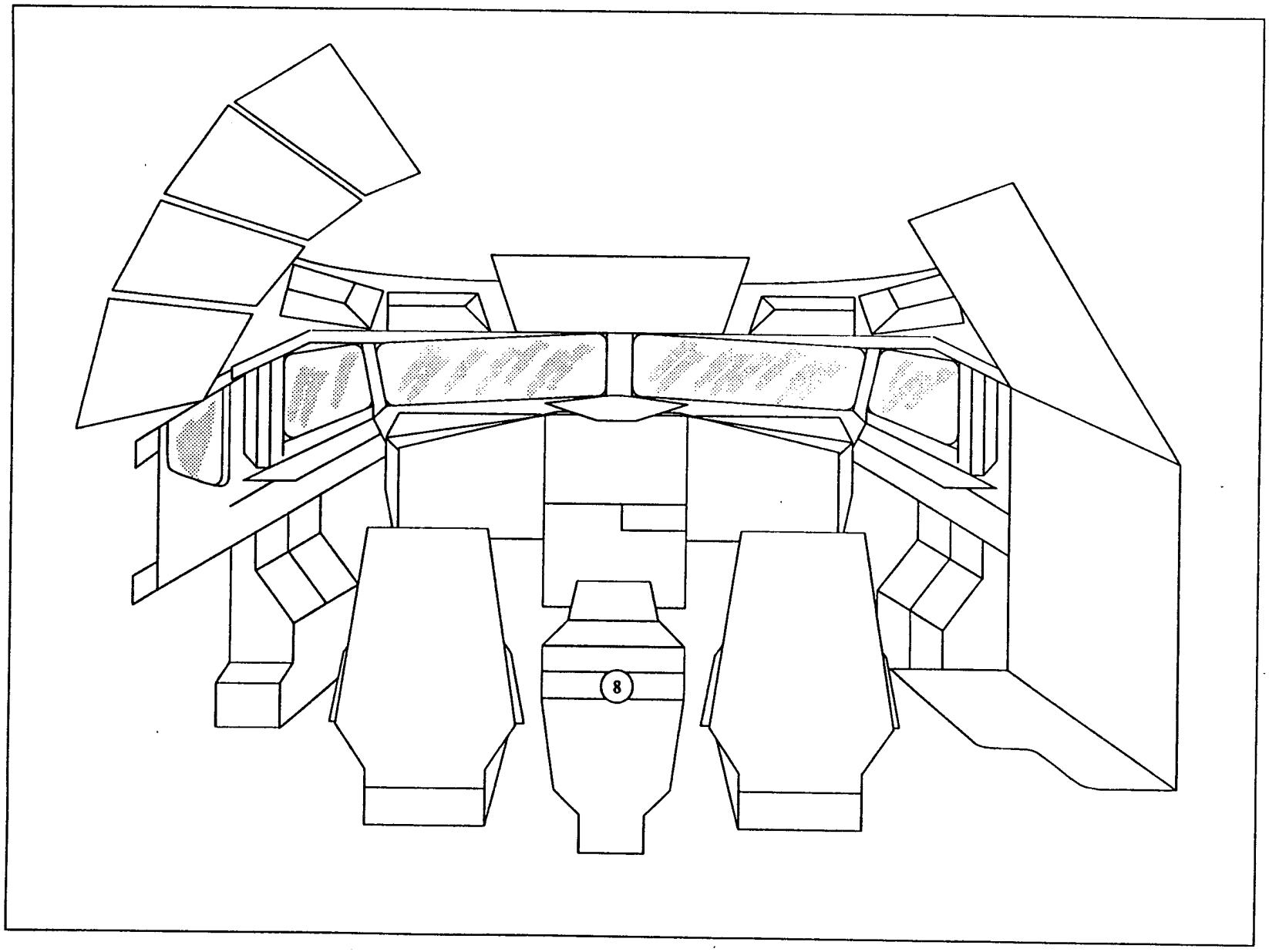


FIGURE B-8. DATA LINK DEVICE LOCATION 8
CENTER PEDESTAL AFT MIDDLE

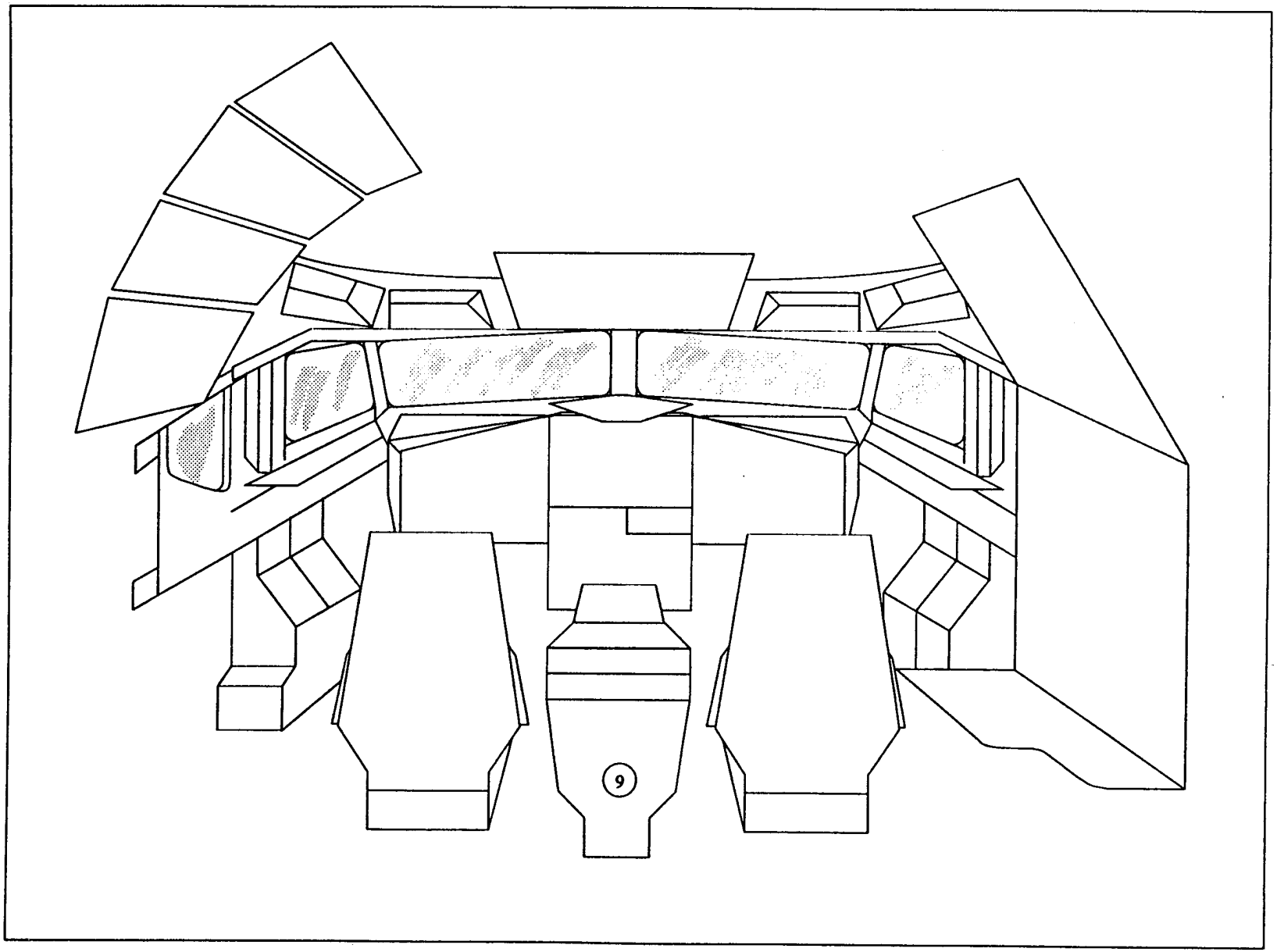


FIGURE B-9. DATA LINK DEVICE LOCATION 9
CENTER PEDESTAL VERTICAL LOWER MIDDLE

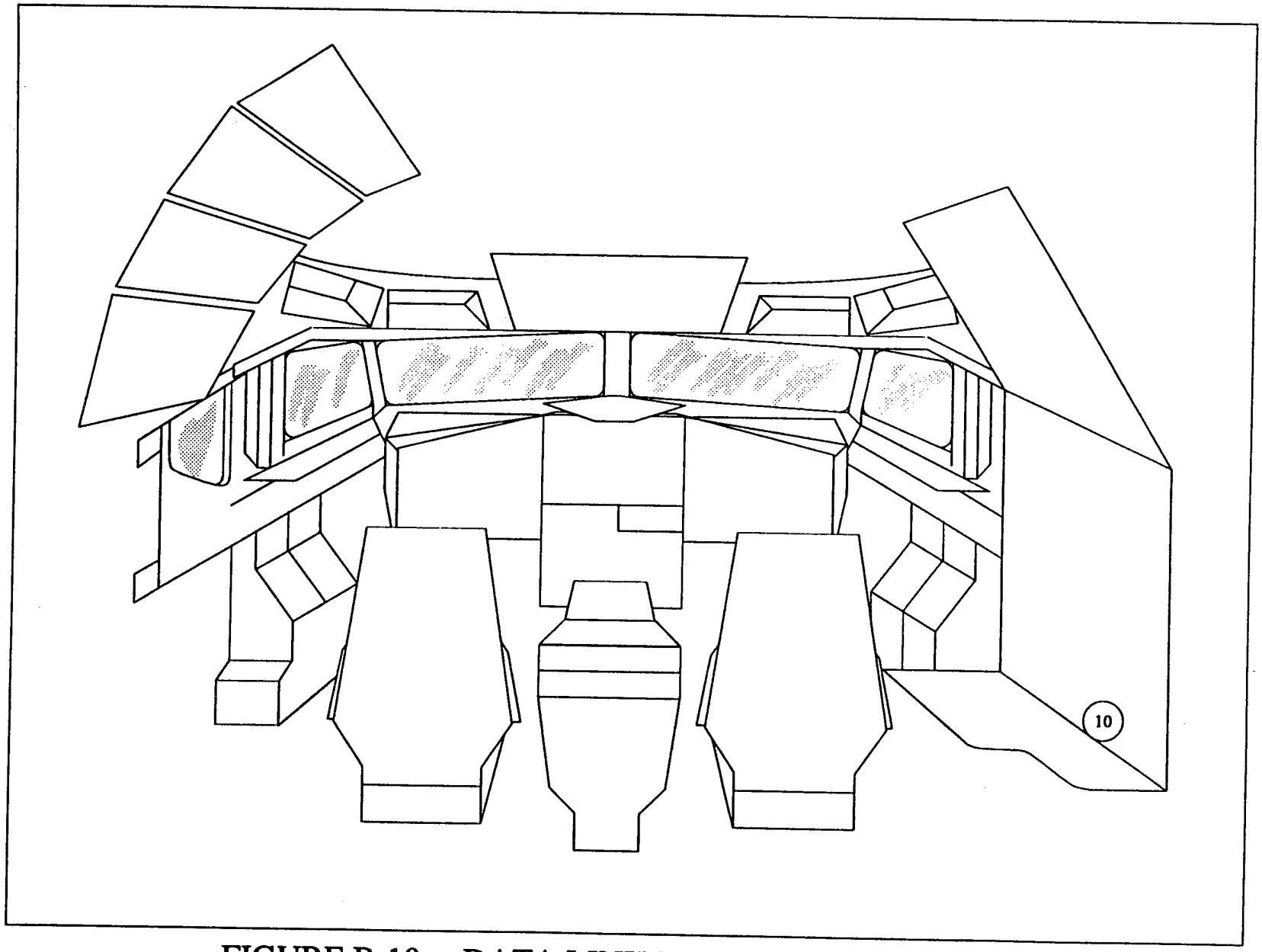


FIGURE B-10. DATA LINK DEVICE LOCATION 10
FLIGHT ENGINEER PANEL LOWER
RIGHT